grew for the ſpace of ſix Days; after which they laid themſelves up in their Bags. Thus they remain'd for two Days more without Motion, and then came forth in the Shape of Flies. (Fig. 5.) The Water at that time was all gone, and there remain'd no more of the Fruit than the Seeds, the Veſſels which compoſed the Tunicks of the Ovarys, the outward Rind, and the Excrement of the Maggots; all which together weigh'd about an Ounce. So that there was loſt of the firſt weight of the Fruit when it was cut, above twenty Ounces.

We may Judge from this, and other Caſes of the like nature, how much Vegetable Life is dependent on Fermentation, and Animal Life on Putrifaction.

VII. *The Art of* Living *under* Water: *Or, a Diſcourſe concerning the Means of furniſhing* Air *at the Bottom of the* Sea, *in any ordinary Depths.*

By Edm. Halley, LL. D. *Secretary to the* Royal Society.

THere have been many Methods propoſed, and Engines contrived, for enabling *Men* to abide a competent while under *Water:* And the Reſpiring freſh *Air* being found to be abſolutely neceſſary to maintain Life in all that breath, ſeveral ways have been thought of, for carrying this *Pabulum Vitæ* down to the *Diver,* who muſt, without being ſomehow ſupplied therewith, return very ſoon, or periſh.

We have heard of the *Divers* for Spunges in the *Archipelago,* helping themſelves by carrying down *Spunges* dipt in Oyl in their Mouths: but conſidering how ſmall a Quantity of *Air* can be ſuppoſed to be contained in the

the Pores or Interſtices of a *Spunge*, and how much that little will be contracted by the Preſſure of the *incumbent Water*, it cannot be believed that a Supply, by this means obtained, can long ſubſiſt a Diver. Since by Experiment it is found that a *Gallon* of *Air*, included in a *Bladder*, and by a Pipe reciprocally inſpired and expired by the *Lungs* of a Man, will become unfit for any further Reſpiration, in little more than one Minute of Time; and though its Elaſticity be but little altered, yet in paſſing the *Lungs*, it loſes its *vivifying Spirit*, and is rendred effete, not unlike the *Medium* found in *Damps*, which is preſent Death to thoſe that breath it; and which in an inſtant extinguiſhes the brighteſt *Flame*, or the ſhining of glowing *Coals* or red hot *Iron*, if put into it. I ſhall not go about to ſhew what it is the *Air* loſes by being taken into the *Lungs*, or what it communicates to the *Blood* by the extream ramifications of the *Aſpera Arteria*, ſo intimately interwoven with the Capillary *Blood-Veſſels*; much leſs to explain how 'tis performed, ſince no diſcovery has yet been made, to prove that the ultimate Branches of the *Veins* and *Arteries* there, have any *Anaſtomoſes* with thoſe of the *Trachæa*; as by the *Microſcope* they are found to have with one another. But I rather chooſe to leave this Enquiry to the Curious *Anatomiſt*, to whom the Structure of the *Lungs* is better underſtood; and ſhall only conclude from the aforeſaid Experiment, that a naked Diver, without a *Spunge*, may not be above a couple of Minutes encloſed in Water, (as I once ſaw a *Florida-Indian* at *Bermudas*) nor much longer with a *Spunge*, without Suffocating; and not near ſo long without great Uſe and Practice: ordinary Perſons generally beginning to ſtifle in about half a Minute of Time. Beſides if the Depth be conſiderable, the preſſure of the *Water* on the Veſſels is found by Experience to make

the

the Eyes Blood-ſhot, and frequently to occaſion ſpitting of Blood.

When therefore there has been occaſion to continue long at the *Bottom*, ſome have contrived double flexible Pipes, to circulate *Air* down into a Cavity encloſing the *Diver* as with Armour, to bear off this preſſure of the *Water*, and to give leave to his Breaſt to dilate upon *Inſpiration*: the freſh *Air* being forced down by one of the Pipes with *Bellowes* or otherwiſe, and returning by the other of them; not unlike to an *Artery* and *Vein*. This has indeed been found ſufficient for ſmall Depths, not exceeding twelve or fifteen Foot: but when the Depth ſurpaſſes three Fathoms, Experience teaches us that this Method becomes impracticable: for though the Pipes and the reſt of the *Apparatus* may be contrived to perform their Office duly, yet the *Water*, its weight being now become conſiderable, does ſo cloſely embrace and claſp the Limbs that are bare, or covered with a flexible Covering, that it obſtructs the Circulation of the *Blood* in them; and preſſes with ſo much force on all the Junctures, where the *Armour* is made tight with *Leather*, *Skins* or ſuch like, that if there be the leaſt defect in any of them, the whole Engine will inſtantly fill with Water, which will ruſh in with ſo much violence, as to endanger the Life of the Man below, who may be drown'd before he can be drawn up. Upon both which accounts, the danger encreaſes with the Depth. Beſides a Man thus ſhut up in a weighty *Caſe*, as this muſt needs be, cannot but be very unwieldy and unactive, and therefore unfit to execute what he is deſigned to do at the Bottom.

To remedy theſe Inconveniences, the *Diving-Bell* was next thought of; wherein the *Diver* is ſafely conveyed into any reaſonable Depth, and may ſtay more or leſs time under *Water*, according as the *Bell* is of greater or leſſer Capacity. This is moſt conveniently made in form of a *Truncate Cone*, the ſmaller *Baſis* being cloſed, and the larger open: and ought to be ſo poized with *Lead*, and ſo ſuſpended, that the Veſſel may ſink full of *Air*, with its greater or open *Baſis* downwards, and as near as may be in a ſituation parallel to the *Horizon*, ſo as to cloſe with the Surface of the Water all at once. Under this Couvercle the Diver ſetting, ſinks down together with the included *Air* into the Depth deſired; and if the Cavity of the Veſſel may contain a Tun of *Water*, a ſingle Man may remain therein at leaſt an Hour, without much inconvenience, at five or ſix Fathoms Deep. But this included Air, as it deſcends lower, does contract it ſelf according to the weight of the Water that compreſſes it; ſo as at thirty three Foot deep or thereabouts, the Bell will be half full of Water, the Preſſure of it being then equal to that of the whole Atmoſphere: and at all other Depths, the ſpace occupied by the compreſt Air in the upper part of the *Bell*, will be to the under part of its Capacity fill'd with Water, as thirty three Feet to the depth of the Surface of the Water in the Bell below the common Surface thereof. And this condenſed Air, being taken in with the Breath, ſoon inſinuates itſelf into all the Cavities of the Body, and has no ſenſible effect, if the Bell be permitted to deſcend ſo ſlowly as to allow time for that purpoſe. The only inconvenience that attends it, is found in the Ears, within which there are Cavities opening only outwards, and that by Pores ſo ſmall as not to give admiſſion even to the Air itſelf, unleſs they be dilated and diſtended by a conſiderable Force. Hence on the firſt deſcent of the Bell, a Preſſure begins to be felt on each Ear, which by degrees grows painful, like as if a Quill were forcibly thruſt into the Hole of the Ear; till at length, the force overcoming the Obſtacle, that which conſtringes theſe Pores yields to the Preſſure, and letting ſome condenſed Air ſlip in, preſent Eaſe enſues.

But

But the Bell deſcending ſtill lower, the Pain is renewed, and again eaſed after the ſame manner. On the contrary, when the Engine is drawn up again, the condenſed Air finds a much eaſier Paſſage out of thoſe Cavities, and even without Pain. This Force on the auditory Paſſages might poſſibly be ſuſpected to be prejudicial to the Organs of Hearing, but that Experience teaches otherwiſe. But what is more inconvenient in this Engine, is the Water entring into it, ſo as to contract the bulk of Air (according to the aforeſaid Rule) into ſo ſmall a ſpace, as that it ſoon heats and becomes unfit for Reſpiration, for which reaſon it muſt be often drawn up to recruit it: and beſides the Diver being almoſt covered with the Water thus entring into his Receptacle, will not be long able to endure the Cold thereof.

Being engaged in an Affair that required the Skill of continuing under Water, I found it neceſſary to obviate theſe Difficulties which attend the uſe of the common Diving-Bell, by inventing ſome means to convey Air down to it, whilſt below; whereby not only the Air included therein, would be refreſh'd and recruited, but alſo the Water wholly driven out, in whatever Depth it was. This I effected by a Contrivance ſo eaſy, that it may be wondred it ſhould not have been thought of ſooner, and capable of furniſhing Air at the bottom of the Sea in any quantity deſired. The deſcription of my *Apparatus*, take as follows.

The Bell I made uſe of was of Wood, containing about 60 Cubick Foot in its Concavity, and was of the form of a Truncate-Cone, whoſe Diameter at Top was three Foot, and at Bottom five. This I coated with Lead ſo heavy that it would ſink empty, and I diſtributed the weight ſo about its bottom, that it would go down in a perpendicular Situation and no other. In the Top, I fixed a ſtrong but clear Glaſs, as a Window to let in the

Light from above; and likewiſe a Cock to let out the hot Air that had been Breathed; and below, about a Yard under the Bell, I placed a *Stage* which hung by three Ropes, each of which was charged with about one Hundred Weight, to keep it ſteddy. This Machine I ſuſpended from the Maſt of a Ship, by a *Spritt* which was ſufficiently ſecured by *Stays* to the Maſt-head, and was directed by *Braces* to carry it over-board clear of the Ship ſide, and to bring it again within-board as occaſion required.

To ſupply Air to this Bell when under Water, I cauſed a couple of Barrels, of about 36 Gallons each, to be caſed with Lead, ſo as to ſink empty; each having a Bung-hole in its loweſt Part to let in the Water, as the Air in them condenſed on their deſcent; and to let it out again, when they were drawn up full from below. And to a Hole in the uppermoſt Part of theſe Barrels I fixed a Leathern Trunk or Hoſe, well liquored with Bees-Wax and Oyl, and long enough to fall below the Bung-hole, being kept down by a Weight appended; ſo that the Air in the upper Part of the Barrels could not eſcape, unleſs the lower ends of theſe Hoſe were firſt lifted up.

The Air-Barrels being thus prepared, I fitted them with Tackle proper to make them riſe and fall alternately, after the manner of two Buckets in a Well; which was done with ſo much eaſe, that two Men, with leſs than half their Strength, could perform all the Labour required: and in their deſcent they were directed by Lines faſtned to the under edge of the Bell, the which paſt through Rings placed on both ſides the Leathern *Hoſe* in each Barrel; ſo that ſliding down by thoſe Lines, they came readily to the Hand of a Man, who ſtood on the Stage on purpoſe to receive them, and to take up the ends of the *Hoſe* into the *Bell*. Through theſe Hoſe, as ſoon as their ends came above the Surface of the Water in the

the Barrels, all the Air that was included in the upper Parts of them was blown with great force into the Bell, whilſt the Water entred at the Bung-holes below, and fill'd them: and ſo ſoon as the Air of the one Barrel had been thus received; upon a ſignal given, That was drawn up, and at the ſame time the Other deſcended; and by an alternate Succeſſion furniſhed Air ſo quick, and in ſo great Plenty, that I my ſelf have been One of Five who have been together at the Bottom, in nine or ten Fathoms Water, for above an Hour and half at a time, without any ſort of ill conſequence: and I might have continued there as long as I pleaſed, for any thing that appeared to the contrary. Beſides the whole Cavity of the Bell was kept entirely free from Water, ſo that I ſat on a Bench, which was diametrically placed near the Bottom, wholly dreſt with all my Cloaths on. I only obſerved, that it was neceſſary to be let down gradually at firſt, as about 12 Foot at a time; and then to ſtop and drive out the Water that entred, by receiving three or four Barrels of freſh Air, before I deſcended further. But being arrived at the Depth deſigned, I then let out as much of the hot Air that had been Breathed, as each Barrel would repleniſh with Cool, by means of the Cock at the Top of the Bell; through whoſe Aperture, though very ſmall, the Air would ruſh with ſo much violence, as to make the Surface of the Sea boyle, and to cover it with a white Foam, notwithſtanding the great weight of Water over us.

Thus I found I could do any thing that was required to be done juſt under us; and that, by taking off the Stage, I could, for a ſpace as wide as the Circuit of the Bell, lay the Bottom of the Sea ſo far Dry, as not to be over-ſhoes thereon. And by the Glaſs Window, ſo much Light was tranſmitted, that, when the Sea was clear, and eſpecially when the Sun ſhone, I could ſee perfectly well to Write or Read, much more to faſten or lay hold on any thing under us, that was to be taken up. And by the return of the Air-Barrels, I often ſent up Orders, written with an Iron Pen on ſmall Plates of Lead, directing how to move us from Place to Place as occaſion required. At other times when the Water was troubled and thick, it would be dark as Night below; but in ſuch Caſe, I have been able to keep a Candle burning in the Bell as long as I pleas'd, notwithſtanding the great expence of Air requiſite to maintain Flame.

This I take to be an Invention applicable to various Uſes; ſuch as *Fiſhing* for *Pearl*, Diving for Coral, Spunges and the like, in far greater Depths than has hitherto been thought poſſible. Alſo for the fitting and plaining of the Foundations of Moles, Bridges, *&c.* upon Rocky Bottoms; and for the cleaning and ſcrubbing of Ships Bottoms when foul, in calm Weather at Sea. But as I have no experience of theſe matters, I leave them to thoſe that pleaſe to try. I ſhall only intimate, that by an additional Contrivance, I have found it not impracticable for a Diver to go out of our Engine, to a good diſtance from it, the Air being conveyed to him with a continued Stream by ſmall flexible Pipes; which Pipes may ſerve as a Clew to direct him back again, when he would return to the Bell. But of this perhaps more hereafter.

VIII. *Obſervations on the* Glands *in the* *Human* Spleen; *and on a Fracture in the upper part of the* Thigh-bone. *By* J. Douglaſs, M.D. *and* R. S. S.

THat Anatomy, as well as Phyſick and Surgery, has received much improvement from a careful and true obſervation of what was found in the Diſſection of morbid